Test Plan for the Fernald Accelerated Waste Retrieval (AWR) Project

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1.0 Background

Operable Unit 4 at the Fernald Environmental Management Project near Cincinnati Ohio includes two domed silos that contain almost 10,000 tons of radium-bearing, low-level waste. The waste, known as K-65 waste, consists primarily of solids of raffinates from processing operations on Belgian Congo ores for the recovery of uranium. These silos are 80 ft in diameter, 36 ft high to the center of the dome, and 26.75 ft to the top of the vertical side walls. The silos were constructed in 1951 and 1952 of concrete wrapped with steel post-tensioning wires and the sides were covered with gunite. The silos have an underdrain system and decant sump tank to collect any potential leakage through the base of the silos. Earthen berms have been placed around the outside silo walls and a radon collection system installed to reduce exposure levels to workers and release to the environment. Details on the construction of the silos and the radon treatment system has been documented in a Fernald Report.[1]

Waste materials were originally transferred to Silos 1 and 2 by pumping the wastes in the form of a slurry. The waste solids settled and the slurry liquid was removed by decant ports located in two vertical lines on diametrically opposed sides of each silo, with the lowest port located 1 ft from the bottom. Silo 1 contains 115,900 ft3 of K-65 waste and 12,600 ft3 of a commercial grade of bentonite clay know as Bentogrout . Silo 2 contains 100,400 ft3 of K-65 waste and 11,100 ft3 of Bentogrout. The Bentogrout in both silos was added in 1991 in the form of a Bentogrout layer over the existing K65 waste to reduce the potential for radioactive emissions to the environment. Details on the waste materials in the silos has been documented in a Fernald Report.[1]

In 1993 and 1994, a remedial investigation and a feasibility study for remediation of silos 1 and 2 were issued in accordance with CERCLA guidelines. The feasibility study evaluated four technologies (mechanical, hydraulic, and pneumatic) for retrieval of the K-65 material from the silos. In December 1994, the Record of Decision calling for slurrying and pumping the waste from the silos was approved by the Environmental Protection Agency. The Technical Requirements Document states that retrieval operations must minimize water accumulation in the silos. Final disposal of the silo structures is dismantlement and shipment to the Nevada Test Site.

The Accelerated Waste Retrieval (AWR) project has been funded to extract the material from silos 1 and 2, transfer the material to interim storage tanks for staging before final remediation, reduce the radon concentration in the silos' headspace, provide radon control during retrieval and material storage, clean the silos and equipment for system closure, and handle secondary waste generated during the AWRP. Design of the bulk waste retrieval system for the silos was prepared by Foster Wheeler in 1999-2000 and calls for hydraulic sluicing of the waste into four 750,000 gallon interim storage tanks. Information on the Foster Wheeler design has been previously documented.[2]

DOE Fernald and their site contractor, Fluor Fernald, are currently performing a due diligence on the Foster Wheeler design. As part of the due-diligence effort, DOE Fernald requested that the DOE Office of Science and Technology provide assistance in organizing a technical working meeting to discuss lessons learned from prior experiences at DOE sites with similar problems. A technical working meeting which included experts from industry, DOE facilities, and universities, was held on October 10 and 11, 2001 at the Fluor offices at Springdale Center. The experts felt that the most critical item of concern was the waste retrieval. Recommendations were made on modifying the sluicing design in terms of the number and locations of sluice nozzles, the pump selection, and the pump location. The team of experts also recommended a test system be built and that numerous surrogate tests be conducted to assist with pump selection, operation and maintenance, as well as nozzle operation and optimization of the sluicing system characteristics. This test plan details the test systems to be used to collect this data, the tests to be conducted, and the information to be provided from the tests.

2.0 Designation of Core Team and Key Responsibilities

In order to ensure a successful demonstration for the AWR and that the demonstration is completed on a time line which will support the current AWR schedule, a core team from private industry and DOE contractors have been assembled to plan and conduct the demonstration. Project oversight is provided by Fluor-Fernald, Jacobs Engineering is responsible for pump selection with input from all team core team members, Oak Ridge National Laboratory (ORNL) is responsible for preparation of the test plan with input from the core team, The Providence Group Applied Technology (TPG) is responsible system design, system construction, and system operation, and Pacific Northwest Laboratory (PNL) is responsible for the surrogate specification. Since much of the data evaluation will be objective and based on visual observations it is important to have multiple organizations involved in the data evaluation and reporting. ORNL will be responsible for testing oversight and will be involved in data evaluation and report preparation, along with TPG. Fluor-Fernald will be responsible for publication and distribution of the final report. The designation of responsible organizations and personnel are summarized in Table 1.

Table 1. Designation of responsibilities for Core Cold Loop Test Team.

Item	Responsible Organization	Responsible Personnel
Project Oversight	Fluor-Fernald	Joel Bradburne Mike Connors
Pump Selection	Jacobs	T. J. Abraham Tom Conrad
Test Plan	ORNL	Joe Walker Ben Lewis
Test System Design	TPG	Jim Blank
Test System Construction	TPG	Jim Blank
Surrogate Specification	PNL	Dennis Mullen Mike Rinker Brian Hatchell
Test System Operation And Data Collection	TPG	Pelar Metcalf Jim Blank

Testing Oversight	ORNL	Joe Walker Ben Lewis
Data Evaluation	ORNL TPG	Joe Walker Jim Blank
Report Preparation	ORNL TPG	Joe Walker Jim Blank
Report Publication	Fluor-Fernald	Joel Bradburne Mike Connor

3.0 Test Facility and Systems

In general, the non-radioactive tests to be conducted in support of the Fernald Bulk Waste Retrieval Project can be broken down into two major divisions: (1) tests to evaluate the operation of the waste retrieval process as a whole and (2) tests to evaluate the individual components of the waste retrieval system. Two individual tests loops, the Integrated Test Loop (ITL) and the Component Test Loop (CTL), will be constructed and operated to provide the data necessary evaluate the design and the equipment selection for the retrieval of the bulk waste from Fernald Silos 1 and 2. To make sure data taken from instruments in the CTL and ITL systems are accurate, instruments will be calibrated prior to testing and the calibration will be checked again after testing.

3.1 Pump Selection

Selection of a slurry pump for mobilization of the solids in the silos is critical for success of the AWR project. A set of criteria was developed by the cold test loop team (representatives from TPG applied technologies, Oak Ridge National Laboratory, Fluor Fernald, and Jacobs Engineering) to aid in the screening of slurry pumps available on the market. A search for the slurry pumps was conducted using internet resources, vendor catalogues, peer consultation, and vendor contacts. The slurry pump selected for use in the test facilities for the AWR project was manufactured by Hazelton. Details on the pump selection have been provided in a Jacobs Engineering report. Specifications for the selected Hazelton pumps are provided in Table 2. [3]

Table 2. Specifications for the Hazelton pump to be tested in the cold test facility.

- The pump will pump 350 gallons per minute
- A minimum of 260 gal/min pump flow is recommended
- The total dynamic head for the pump is 208 ft.
- The pump has an efficiency of 52%
- The pump has a WHP of 35.4 with clear water
- The pump has a BHP of 42.4 at a specific gravity of 1.20
- The pump includes a 125 HP motor at 1,800 rpm
- The pump has a 3 inch discharge flange (150# ANSI)
- The maximum spherical solids through the impeller is 1.25 inches

- A NPSH of 32 feet is available
- A 20 inch minimum submergence over the suction inlet is required for full flow
- The normal pump operating temperature is ambient
- The impeller has a design diameter of 18 inches

3.2 Integrated Test Loop
Details on the tests to be conducted in the ITL and the objectives for those tests are presented in Section 4 of this Test Plan. A brief description of the ITL and the general objectives of this system are included in this section.

A Piping and Instrument Diagram (P&ID) for the ITL is presented in Figure 1. This system has been designed for multiple short runs of ~ 1 hour in duration. The surrogate material, which is being specified by PNL to simulate the contents of the silos, will be placed in the surrogate material tank. The surrogate material tank has been sized to simulate a section of the actual geometry of the silos to be remediated. The K-65 material will be ~8 ft high at the center and 6 ft high at the edges, to simulate the actual geometry of the waste in the silos. The surrogate material tank has been equipped with two sluicers and a slurry pump, which are positioned to simulate the distances between the sluicers, the pump and the silo wall in the actual bulk waste retrieval system planned for deployment in the silos. The nozzles and slurry pump are full scale and identical to those planned for deployment. The surrogate material tank will also have standpipes for determining the depth of liquid in the tank.

Water from the Decant Tank #1 will be pumped to the sluice nozzles. Various nozzles and flows will be tested to develop a mining strategy which will be successful in mobilizing the solids. The concentration ranges of K-65 surrogate and Bentogrout which are expected to be encountered in the silos will be utilized to evaluate the effectiveness of nozzles. Flow, pressure, and percent solids in the sluice water will be continuously logged and an Isolok sampler will be included for sampling the sluice water line.

The slurry pump located in the surrogate material tank will be utilized to transfer the slurry to Decant Tank #2. The pressure, flow, and percent solids of the slurry will be continuously logged and an Isolok sampler located on the slurry pump effluent line will be used to pull samples. The solids will be allowed to settle in Decant Tank #2 and the liquid will be pumped into Decant Tank #1

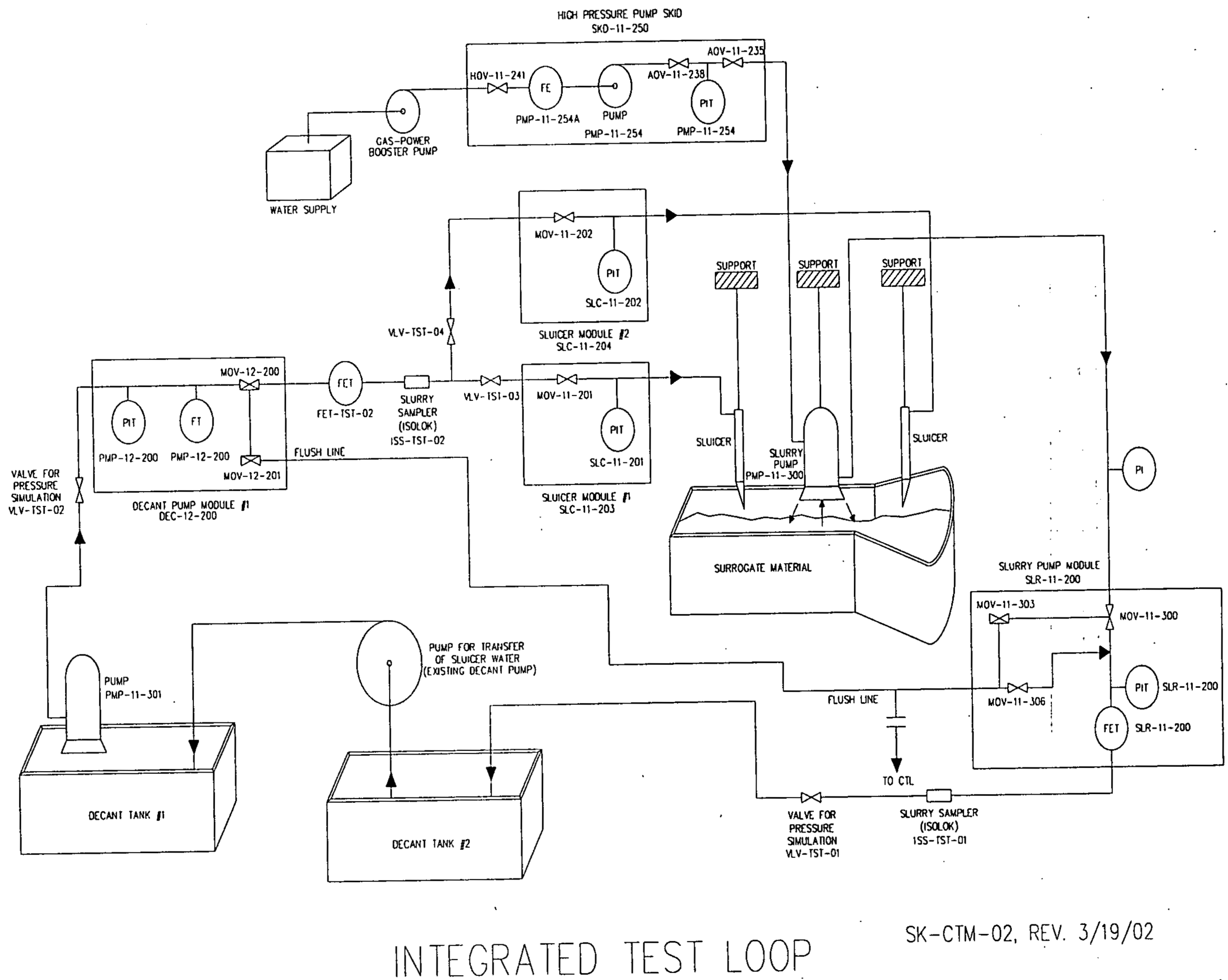

Fig. 1. Piping and Instrument Diagram for the Integrated Test Loop.

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Grab samples will be taken from the inlet line to Decant Tank #2 and used to determine the settling rate of the solids. This settling rate will determine the number of ITL runs which can be conducted during the test period. The effectiveness of the slurry pump in mobilizing various combinations of K-65 surrogate and Bentogrout will be determined. The pump has also been designed to accommodate a spray ring which operates at flows up to 40 gal/min and pressures up to 3000 psig. The effectiveness of the spray ring in breaking up the Bentogrout cap and in creating a sump for the slurry pump will be evaluated. The effectiveness of the pump and the agitator located on the pump suction will also be evaluated for handling debris which might be located in the silos. If the baseline slurry pump proves ineffective or if problems occur with the pump which cannot be resolved, pumps with different designs will be evaluated.

3.3 Component Test Loop

Details on the tests to be conducted in the CTL and the objectives for those tests are presented in Section 5 of this Test Plan. A brief description of the CTL and the general objectives of this system are included in this section.

A Piping and Instrument Diagram (P&ID) for the CTL is presented in Figure 2. The CTL will be operated around the clock for extended periods to gather data on the individual components which are planned for use in the remediation of the Fernald silos. The water and surrogates are placed in the feed tank and an agitator is used to keep the tank well mixed. The slurry pump, which is identical to the pump planned for deployment in the Fernald silos, circulates the slurry at flows up to ~350 gal/min through the test loop and back to the feed tank. The pressure, flow, percent solids, and the temperature on the pump discharge are continuously logged and an Isolok sampler on the slurry pump effluent line is included for taking grab samples. The CTL contains a valve for adjusting the back pressure on the slurry pump to verify pump curves, as well as clear sections of pipe to determine the critical velocity at which the solids in the surrogates begin to settle. A Test Box located in the loop will contain the various components of particular interest which are to be evaluated during these extended runs. A list of these items will be generated prior to initiating testing.

3.4 Test Facility

The test loops will be assembled and tested in the high bay of TPG Applied Technology located at 10330 Technology Drive in Knoxville, Tennessee. A layout showing the equipment layout and sizes is presented in Figure 3. It should be noted that duplicate Decant Tanks are provided in the ITL in order to increase the run time during these tests. All equipment will be located inside so that weather will not be an issue during testing.

3.5 Surrogate

The waste in the silos to be retrieved, known as K-65 waste, consists primarily of solids of raffinates from processing operations on Belgian Congo ores for the recovery of uranium. The K-65 material contains a significant amount of lead (8.9%), iron (4.1%), and barium (4.4%), therefore it is a little denser, with a specific gravity (average 2.97, standard deviation of 0.13) than typical sands or minerals (specific gravity of 2.65). Personnel from PNL, who have an expertise in surrogate development and specification

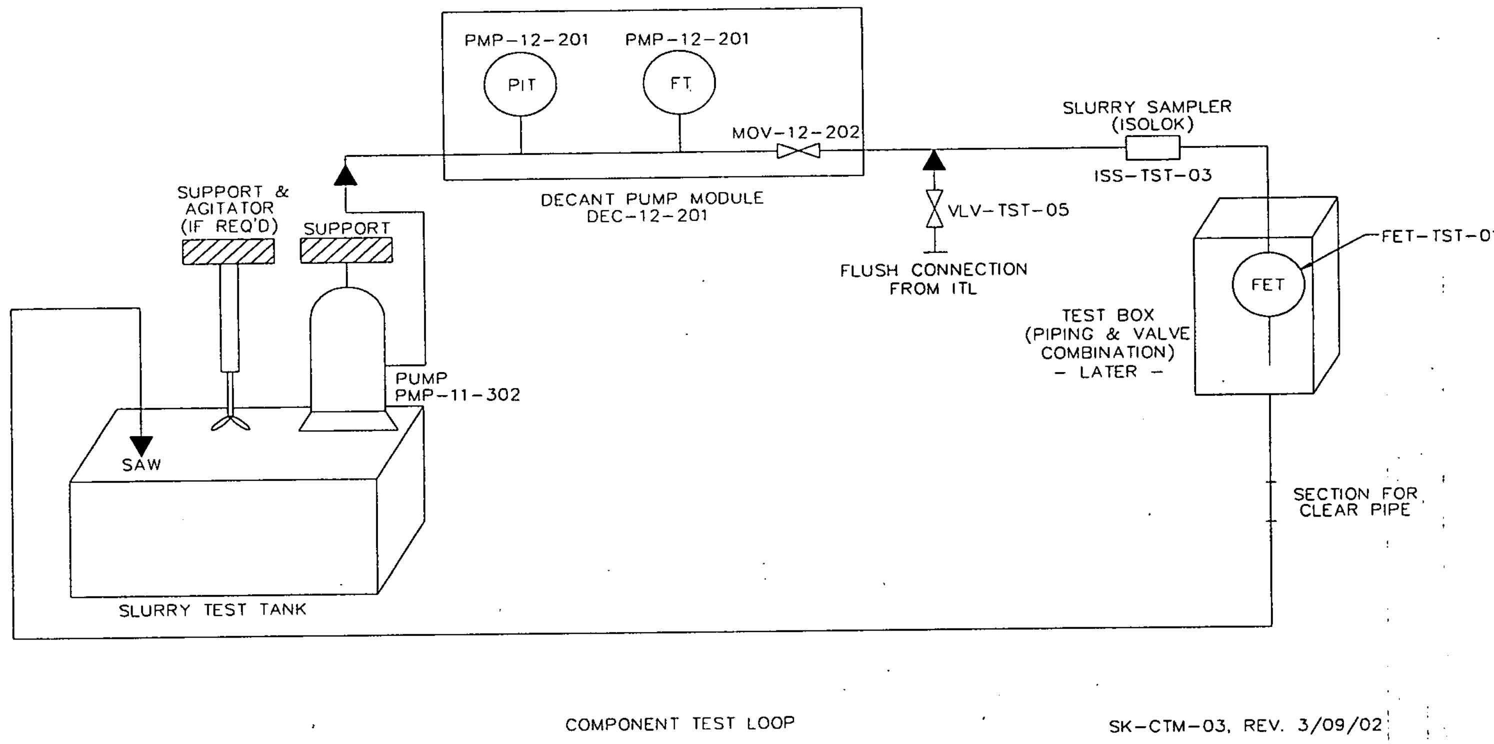

Fig. 2. Piping and Instrument Diagram for the Component Test Loop.

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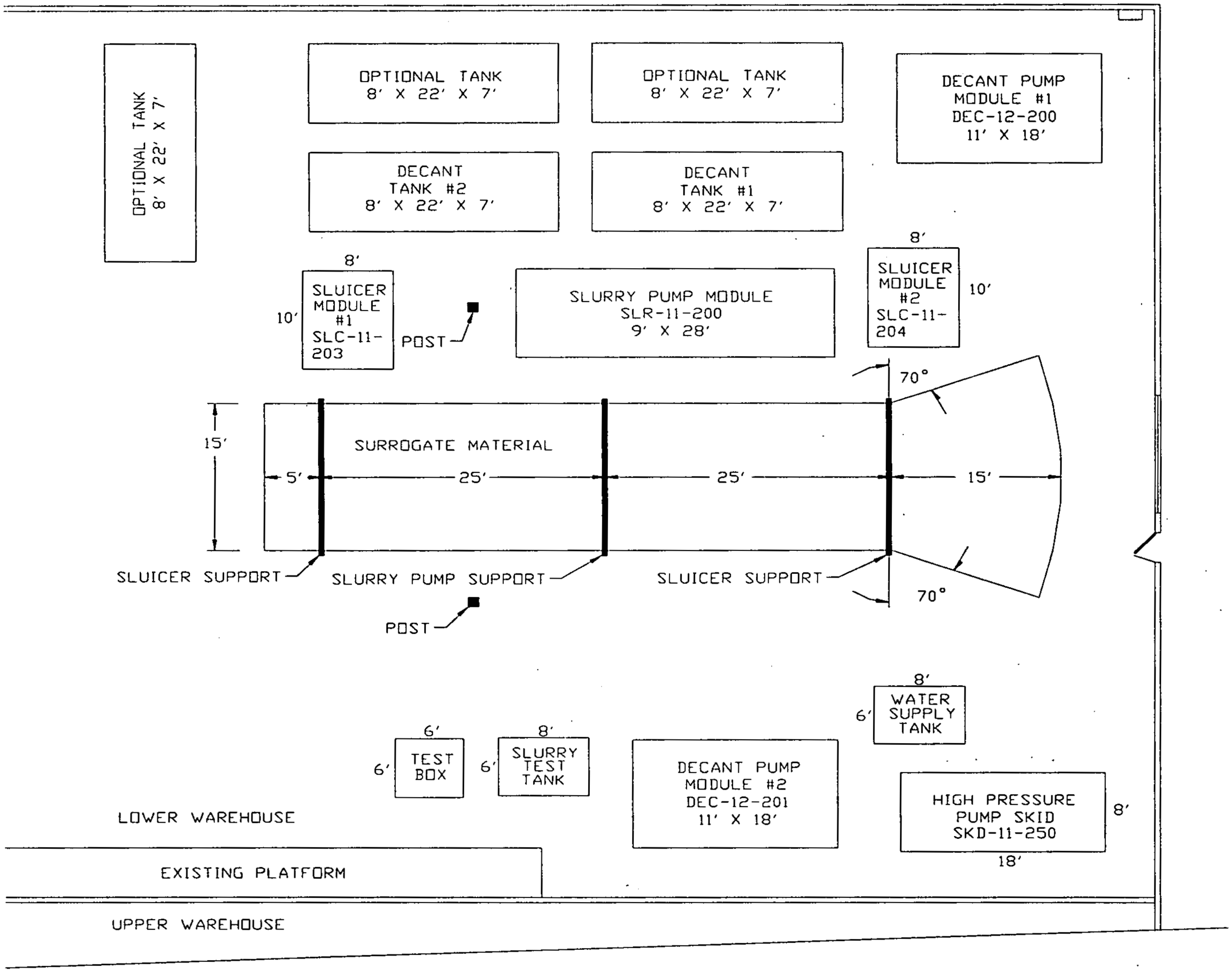

TEST EQUIPMENT LAYOUT

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Fig. 3. Integrated Test Loop and Component Test Loop in the TPG high bay.

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based on previous work with similar wastes, studied the characterization data from the silos and developed a specification for the K-65 surrogate. Information on the surrogate and how it was developed has been summarized in a PNL report. [4]

Personnel from TPG took the specifications developed by PNL staff and identified potential vendors who could provide material close to that specified. By combining 23% of a crushed block material with 77% of a crushed limestone material, TPG was able to come up with a surrogate sufficiently close to the surrogate specified by PNL personnel. The PNL report discusses the issues associated with the variation in the surrogate and the specification requirements. [5] A comparison of the surrogate and the specification is provided in Table 3.

Table 3. Comparison of surrogate and specification requirements.

Screen Size (Mesh)	Block Material (23%) [a]	Lime Material (77%) [a]	Combined Material [a]	Fernald Specifications [a]
No. 4	99	100.0	99.8	100
No. 8	73	99.9	93.7	97.3
No. 16	50	99.0	87.7	93
No. 30	35	98.0	83.5	87.5
No. 50	26	95.9	79.8	79.5
No. 100	19	87.2	71.5	66.5
No. 200	14	67.4	55.1	54
Specific Gravity			2.82	2.97

[a]Percent passing through this size screen but not the next finer.

It should be noted that the block material and lime material will have to be mixed prior to initiating the ITL and CTL testing. Samples of the mixture will be taken and analyzed as this mixing occurs to determine the actual solid size distribution. Adjustments will be made to the size distribution, as necessary, prior to initiating the ITL and CTL tests.

It should also be noted that the K-65 material in both silos were covered with a Bentogrout layer in 1991to reduce the potential for radioactive emissions to the environment. A Bentogrout cap will be placed over the K-65 surrogate during a portion of the ITL testing to simulate the waste in the actual silos. Testing will also be conducted in the CTL with different combinations of K-65/Bentogrout to bound the range of compositions expected to be encountered during the actual remediation of the silos. In addition, debris (i.e., plastic bags) will be added to the surrogates to determine how the slurry pump will handle them.

4.0 Integrated Test Loop Run Details

The ITL has been designed to simulate, at full scale, the integrated bulk retrieval system which will be utilized in the silos at Fernald. A series of short runs will be conducted over an approximate 2 month period, with each run being at lease 1 hour in duration. The time between runs will depend on the settling rate of the surrogate solids in Decant Tank #2. Six series of runs will be conducted with the ITL, with multiple runs possible for each series. The runs in the six series of tests are detailed below.

4.1 ITL Series 1 Runs

The primary objectives of the ITL Series 1 runs are to (1) determine the nozzle configuration which is most effective in mining the K-65 surrogate material, (2) determine the effective radius of the nozzles being tested with K-65 surrogate, and (3) determine the effectiveness of the pump spray ring in forming a sump around the slurry pump with the K-65 surrogate prior to nozzle operation. A minimum of two series 1 runs will be conducted (designated as ITL-1A and ITL-1B). Additional runs will be conducted if the nozzle and spray ring configurations tested in runs ITL-1A and ITL-1B prove ineffective. The following runs will be conducted.

Run Designation	Nozzle Configuration	Spray Ring Configuration
ITL-1A	Two 300 gal/min nozzles operating alternately	Initially run to form sump around pump then turned off
ITL-1B	Two 150 gal/min nozzles operating simultaneously	Initially run to form sump around pump then turned off
ITL-1C (Optional)	Nozzle inserts for flows other than 150 and 300 gal/min (To be determined)	To be determined

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A] as a function of time,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02 as a function of time.
(4) Graph of slurry pump load as a function of time,
(5) Settling rate in Decant Tank #2 (by grab samples from slurry pump discharge), and
(6) Particle size distribution of solids (by grab samples from slurry pump discharge).

Data log sheets for each of these runs in included in Appendices 1-3.

4.2 ITL Series 2 Runs

The primary objectives of the ITL Series 2 runs are to (1) perform an integrated test using the parameters from the ITL Series 1 runs which were most effective in mobilizing he K-65 surrogate, (2) test the operation of the Isolok samplers, (3) verify the range of solids handled by the slurry pump during integrated testing, (4) determine variability in system parameters [i.e., flow, pressure, etc.] during integrated testing, and (5) close the water/solids material balance during the integrated test. At least two run will be conducted and, depending on the results of these two tests, additional series 2 runs may be made.

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A, FET-TST-02] as a function of time,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02, grab samples] as a function of time.
(4) Graph of slurry pump load as a function of time,
(5) Settling rate in Decant Tank #2 (by grab samples from slurry pump discharge), and
(6) Particle size distribution of solids (by grab samples from slurry pump discharge).

Data log sheets for the Series 2 runs are included in Appendix 4 of this test plan.

4.3 ITL Series 3 Runs

The primary objective of the Series 3 runs is to determine the effects of reduced flow on the slurry pump. The pump flow will be decreased in 50 gal/min increments from an initial setting of 350 gal/min to a minimum of 200 gal/min and the effectiveness of the pump in handling the slurries will be noted. Operating personnel will note any visible differences in the effectiveness of the pump in handling the slurry at the reduced flows during the integrated tests. Also, differences in the percent solids in the pump discharge as a function of time and flow rate will be determined by the mass flow meter [FET-SLR-11-200].

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time and pump speed,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A, FET-TST-02] as a function of time and pump speed,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02] as a function of time and pump speed, and
(4) Graph of slurry pump load as a function of time.

Data log sheets for the Series 3 runs are included in Appendix 5 of this test plan.

4.4 ITL Series 4 Runs

A Bentogrout cap will be placed over the K-65 surrogate in the Surrogate Material Tank for the ITL Series 4 runs to simulate the Bentogrout cap in the silos. The K-65/Bentogrout ratio in the Surrogate Material Tank will be similar to that found in the top 15 feet of the silos.. The cap will vary from ~1 ft thick at the rounded end of the Surrogate Material Tank to a couple of inches thick in under the pump in order to simulate the actual conditions of the solids in the silos. The manufacturer's recommendations will be followed to form a hard crust Bentogrout crust prior to starting the ITL Series 4 runs. The primary objectives of the Series 4 runs are to (1) determine if the nozzle and pump configurations which proved effective in mobilizing the K-65 surrogate are effective in mobilizing the K-65/Bentogrout combination, (2) determine if the nozzle and pump configurations which proved effective in mobilizing the K-65 surrogate are effective in breaking up the Bentogrout cap, (3) verify the operation of the mass flow meters and Isolok samplers on the K-65/Bentogrout combination, (4) determine the range of solids handled by the slurry pump during an integrated run with the K-65/Bentogrout combination, (5) close the solids/water material balance for the Series 4 runs, and (6) verify the load on the slurry pump while operating with the K-65/Bentogrout combination. A minimum of three runs will be conducted in order to cover the wide range of K-65/Bentogrout combinations that can be expected in the actual silos. If the nozzle and pump configurations which proved effective for the K-65 only surrogate (in Series 1 and 2 runs) prove to be ineffective with the K-65/Bentogrout combination, different nozzle/pump configurations will be tested.

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A, FET-TST-02] as a function of time,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02, grab samples] as a function of time, and
(4) Graph of slurry pump load as a function of time.

Data log sheets for the Series 4 runs are included in Appendix 6 of this test plan.

4.5 ITL Series 5 Run

The primary objective of the Series 5 run is to determine operational parameters typical of what would happen if the line on the discharge of the slurry pump becomes partially or fully blocked. In this test VLV-TST-01 will be closed in increments, the ITL system allowed to reach steady state, and the process parameters will be determined at each of the valve VLV-TST-01 positions.

The following information will be provided for this run:

(1) Graph of pump discharge pressure (PIT-SLR-200) as a function of time and VLV-TST-01 position,
(2) Graph of flow [FET-SLR-11-200] as a function of time and VLV-TST-01 position,
(3) Graph of slurry pump load as a function of time and valve position.

Data log sheets for the Series 5 runs are included in Appendix 7 of this test plan.

4.6 ITL Series 6 Runs

The primary objective of the Series 6 runs are to determine if the pump can handle debris which might be located in the silo and that can't be removed by long handle tools. Plastic bags will be utilized to simulate the debris

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A, FET-TST-02] as a function of time,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02] as a function of time, and
(4) Graph of slurry pump load as a function of time.

Data log sheets for the Series 5 runs are included in Appendix 8 of this test plan.

4.7 ITL Series 7 Run

The primary objective of the Series 7 run is to cut the power to the ITL system while operating and determining how the system reacts to restarting after an uncontrolled shutdown.

The following information will be provided for each of these runs:

(1) Graph of pressure [PIT-SLR-11-200, PIT-PMP-12-200, PIT-SLC-11-201, PIT-SLC-11-202, PIT-PMP-11-254] as a function of time,
(2) Graph of flow [FET-SLR-11-200, FT-PMP-12-200, FE-PMP-11254A, FET-TST-02] as a function of time,
(3) Graph of percent solids [FET-SLR-11-200, FET-TST-02] as a function of time, and
(4) Graph of slurry pump load as a function of time.

Data log sheets for the Series 6 runs are included in Appendix 9 of this test plan.

5.0 Component Test Loop Run Details

The CTL has been designed to operate continuously around the clock in order to evaluate individual components of the Fernald Bulk Waste Retrieval system. Four series of runs will be conducted with the CTL. These runs are detailed below.

5.1 CTL Series 1 Run

The primary objectives of the Series 1 run are to (1) verify manufacturer pump curves prior to testing, (2) determine the ability of various system components to withstand the erosion/abrasion from the transfer of the K-65 solids, (3) determine the critical velocity of the K-65 surrogate as a function of percent solids, (4) verify the accuracy of the mass flow meters on the K-65 slurry by comparing it with data taken from grab samples using the Isolok sampler during longer periods of operation, and (5) determine the load on the slurry pump as a function of percent solids of K-65. The CTL Series 1 run will have 25 days of around the clock operation and then the CTL system will be shutdown for inspection and measurements of various system components. The Hazelton Pump representative will examine the pump internals after testing and make recommendations on the use of the pump for the actual AWR in the Fernald silos. Since the pump impeller is expected to operate for 3000 hours before having to be replaced due to the abrasive nature of the solids in the silos, 25 days of continuous operation was chosen to represent 20% of the expected wear life for the impeller.

Photographs and ultrasonic measurements will be taken of various system components prior to initiating these tests in order to establish a baseline. Operation will be initiated with a slurry containing ~5% K-65 surrogate solids. The K-65 slurry concentration will be raised to 10% and 15% after 24 and 48 hours of operation, respectively. The test will run continuously for 23 days at 15% K-65 slurry. They CTL will then be shut down, the K-65 slurry will be reduced to 10 wt %, and 1 wt% of hydrated bentonite will be added to the slurry test tank. The CTL will then be operated for 4 hours. After 4 hours of operation, an additional 2 wt% of hydrated bentogrout will be added and the system will be operated for an additional 4 hours.

After each operational period and prior to going to the next higher solids loading, valve (VLV-TST-05) will be adjusted and the critical velocity at which the solids begin to settle will be determined by visual inspection in a clear section of pipe. Data logs for photographs, ultrasonic measurements, sample numbers, and process information is included in Appendix 10.

The following information will be provided for CTL Series 1 run:

(1) Photographs and ultrasonic measurement of test components as a function of time,
(2) Graph of pressure [PIT-PMP-12-201] as a function of time and percent solids,
(3) Graph of flow [FET-TST-01, FT-PMP-12-201] as a function of time and percent solids,
(4) Graph of percent solids [FET-TST-01, Isolok samples] as a function of time,
(5) Graph of critical velocity as a function of percent solids, and
(6) Graph of slurry pump load as a function of time and percent solids.

5.2 CTL Series 2 Runs

The primary objectives of the CTL series 3 runs are to (1) document the operation of the slurry pump on a Bentogrout slurry varying from 1 to 5% by weight, (2) verify the operation of the mass flow meters with grab samples taken with the Isolok samplers while operating with various Bentogrout compositions, (3) determine variability in system parameters [i.e., flow, pressure, etc.] while operating with various concentrations of Bentogrout, (4) determine the load on the slurry pump with various concentrations of Bentogrout, and (5) verify the pump curves on the slurry pump after completion of testing.

The CTL system will be started at 1 weight percent Bentogrout and operated until the system reaches steady state or for at least two hours at this concentration. The weight percent Bentogrout will then be increased in 1% increments up to a maximum of 5%. The system will be operated at steady state, or for at least 2 hours, at each of these concentrations. A composite sample over a 10 minute period will be taken at each of the compositions. Following all testing, water will be used to generate pump curves for comparison with those curves generated prior to initiating testing with the CTL system.

The following information will be provided for CTL Series 1 run:

(1) Graph of pressure [PIT-PMP-12-201] as a function of time and slurry composition,
(2) Graph of flow [FET-TST-01, FT-PMP-12-201] as a function of time and slurry composition,
(3) Graph of percent solids [FET-TST-01, Isolok samples] as a function of time and slurry composition, and
(4) Graph of slurry pump load as a function of time and slurry composition.

Data log sheets for the CTL Series 2 run are included in Appendix 11 of this test plan.

6.0 Test Run Evaluations and Final Test Report

After the tests with the ITL and CTL have been completed, the final test report will be prepared. The final test report will address the following questions.

6.1 **What nozzle and slurry pump spray ring configuration performed best at mobilizing the K-65 surrogate?** This is a qualitative evaluation and will be based on the observations of the operating personnel and on others observing the operations. The evaluation will address nozzle flows, nozzle operation (e.g., alternate operation versus simultaneous operation), the ability of the nozzles to cover the diameter of the silos, how effective the configuration of the nozzles was in slurrying the surrogate so it could be mobilized by the slurry pump, how effective the nozzles were in directing the solids to the slurry pump, the ability of the slurry pump to handle the variable flow and solids, and the need for the slurry pump spray ring. Drawings or sketches will be prepared to illustrate the effective diameter of the nozzles and to note any potential problem areas. Graphs of pressures, flows, percent solids, and pump load as a function of time will be included in the evaluation. Data from the ITL Series 1 runs will be used to make this evaluation.

6.2 **What is the range of solids handled by the slurry pump during integrated test runs with the K-65 surrogate?** Data from the Mass Flow Meters and grab samples will be used to prepare graphs showing the range of solids with time handled by the pump during integrated test runs with the K-65 surrogate. A qualitative evaluation will be made as to how well the slurry pump handled this range of solids. Graphs of pressure, flow, and pump load as a function of time and/or percent solids will be used to support the qualitative evaluation. This data will come from the ITL Series 2 runs.

6.3 **How variable are system parameters during integrated testing?** Graphs of pressures, flows, and percent solids as a function of time will be prepared. Any problems noted with the instruments will be noted. This data will come from the ITL Series 2 runs.

6.4 **What is the quantity of water and solids transferred during integrated testing with K-65 surrogate?** The quantity of water and solids transferred during integrated testing will be determined from data provided by mass flow meters and flow transmitters as a function of time. This data will be useful for water and solid material balances for the full scale Fernald Bulk Waste Retrieval operation. The ability to balance the water and solids in and the water and solids out will be evaluated. The performance with and without the benefit of bentogrout will be compared. This data will come from the ITL Series 2 and Series 4 runs.

6.5 **How do system parameters vary with reduced slurry pump flow?** This will be a qualitative evaluation. The slurry pump will be operated at various flows from 200 to 350 gal/min and the ability of the pump to handle the slurry will be evaluated. Graphs of percent solids and pressure in the pump discharge line as a function of time and pump speed will be included in the evaluation. Any potential for the pump to plug at lower flows is a major concern and the evaluation will address this concern. This data will come from the ITL Series 3 runs.

6.7 **Is the nozzle and spray ring configuration, which was most effective in mobilizing the K-65 surrogate effective in mobilizing (1) the Bentogrout cap and/or (2) the variable Bentogrout/K-65 combination?** This will be a qualitative evaluation. The evaluation will note the ability of this configuration to breakup the Bentogrout cap, to slurry the Bentogrout, and to direct the Bentogrout to the slurry pump. The ability of the slurry pump to handle the Bentogrout and Bentogrout/K-65 slurries will also be evaluated. Graphs of pressure, flow, and percent solids on the pump discharge line as a function of time will be used in the evaluation. This data will come from ITL Series 4 runs.

6.8 **If the nozzle and spray ring configuration, which was most effective in mobilizing the K-65 surrogate is not effective in mobilizing the Bentogrout cap and/or the variable Bentogrout/K65 slurry, what nozzle and spray ring configuration is effective?** This will be a qualitative evaluation. Additional runs will have to be performed to make this evaluation. The evaluation will address nozzle flows, nozzle operation (e.g., alternate operation versus simultaneous operation), the ability of the nozzles to cover the diameter of the silos, how effective the configuration of the nozzles was in slurrying the surrogate so it could be mobilized by the slurry pump, how effective the nozzles were in directing the solids to the slurry pump, the ability of the slurry pump to handle the variable flow and solids, and the need for the slurry pump spray ring. Graphs of pressures, flows, percent solids, and pump load as a function of time will be included in the evaluation. This data will come from the ITL Series 4 runs.

6.9 **What is the range of solids handled by the slurry pump during integrated test runs with the Bentogrout/K-65 surrogate combination?** Data from the Mass Flow Meters and grab samples will be used to prepare graphs showing the range of solids with time handled by the pump during integrated test runs with the variable Bentogrout /K-65 surrogate composition. A qualitative evaluation will be made as to how well the slurry pump handled this range of solids. Graphs of pressure, flow, and pump load as a function of time and/or percent solids will be used to support the qualitative evaluation. This data will come from the ITL Series 4 runs.

6.10 **What is the quantity of water and solids transferred during integrated testing with the Bentogrout/K-65 surrogate combination?** The quantity of water and solids transferred during integrated testing will be determined from data provided by mass flow meters and flow transmitters as a function of time. This data will be useful for water and solid material balances for the full scale Fernald Bulk Waste Retrieval operation. This data will come from the ITL Series 4 runs.

6.11 **What is the load on the slurry pump during integrated testing with the Bentogrout/K65 surrogate combination?** Graphs of the pump load as a function of time and/or percent solids will be prepared for this determination. This data will come from the ITL Series 4 runs.

6.12 **How would process parameters be affected in a partial or total blockage of the slurry pump discharge line?** A throttling valve will be used to simulate a partial and total blockage of the discharge line in the ITL. The process parameters will be plotted as a function of time and valve position to determine the effects. This data will come from ITL Series 5 runs.

6.13 **How does the slurry pump handle debris which might be present in the silos?** This will be a qualitative evaluation. The slurry pump will be tested with plastic bags in the simulant. Debris which pass through the pump and debris which cause problems will be noted. Photographs of the debris, both prior to and after processing, will be used to support the evaluation. Graphs of pressure and flow on the slurry pump discharge line as a function of time will be considered in the evaluation. This data will come from the ITL Series 6 runs.

6.14 **How does the system respond when restarted after an off-normal shutdown?** Power to the system will be shut off and system parameters will be followed during the re-start. This data will come from ITL Series 7 runs.

6.15 **How do the various system components stand up to the abrasion/erosion caused by the transport of the abrasive K-65 slurry?** This will be a qualitative evaluation. Components to be evaluated will be photographed and/or measured ultrasonically prior to testing in the CTL to form a baseline. Photographs and/or ultrasonic measurements will be taken periodically during a 37 days continuous around the clock run. These will be compared to the baseline analyses and a table showing acceptable and non-acceptable components will be prepared. This data will come from the CTL Series 1 runs.

6.16 **What is the critical velocity of the K-65 surrogate as a function of percent solids?** The velocity at which different concentrations of K-65 settles will be determined by visual observation in a clear section of pipe and a graph will be presented. This data will come from the CTL Series 1 runs.

6.17 **How does the results from the Mass Flow Meters compare with lab measurements from grab samples taken with the Isolok samplers on the K-65 surrogate during long term testing?** The percent solids from the mass flow meters and the grab samples will be quantitatively compared. This data will come from the CTL Series 1 runs.

6.18 **What is the load on the slurry pump as a function of percent solids being pumped?** The pump load will be continually logged during a 25 day continuous run and a graph of the pump load versus percent solids of K-65 will be prepared. This data will come from the CTL Series 1 runs.

6.19 **How do system parameters vary during a long term test and with differing K-65 solids concentrations?** Graphs of pressure, flow, and percent solids logged by the DAS will be presented. This data will come from the CTL Series 1 runs.

6.20 **How does the slurry pump handle a wide range of Bentogrout/K-65 compositions and how do system parameters vary over this concentration range?** This will be a qualitative evaluation. The CTL system will be operated over a wide range of Bentogrout/K-65 compositions and graphs of pressure, flow, percent solids, and pump load will be made from data logged by DAS as a function of time and/or composition. Problems which occur with the pump at any of these compositions will be noted. This data will come from the CTL Series 1 and 2 runs.

6.21 **How does the results from the Mass Flow Meters compare with lab measurements from grab samples taken with the Isolok samplers during long term testing over a wide range of Bentogrout/K-65 compositions?** The percent solids from the mass flow meters and the grab samples will be quantitatively compared. This data will come from the CTL Series 1 and 2 runs.

6.22 **What is the critical velocity over a wide range of Bentogrout/K-65 compositions?** The velocity at which different compositions of Bentogrout/ K-65 settle will be determined by visual observation in a clear section of pipe and a graph will be presented. This data will come from the CTL Series 1 and 2 runs.

6.23 **What operational procedures should be used for normal startup, off-normal startup (i.e., after a shutdown trigger by the control system), and normal shutdown?** Based on information generated during testing, operational procedures will be developed.

7.0 References

1. Fernald Report, FEMP-04RI-6 FINAL, November 3, 1993.

2. System Design Descriptions for the Silos 1 and 2 Accelerated Waste Retrieval Project, Foster Wheeler Environmental Corporation Document No. 624-P622-30, Rev 1, Contract No. FSC 624, Submitted to Fluor Fernald, Inc. November 16, 2000.

3. Selection of a Slurry Pump for the Accelerated Waste Retrieval Project, Jacobs Engineering, Document No. 40710-RP-0013, March 2002.

4. Personal correspondence from Dennis Mullen, February 27, 2002.

5. Comparison of Surrogate Specifications and Actual Surrogate Used in AWR Tests, to be prepared by Dennis Mullen.

8.0 Appendices

Appendix 1

Data Logs For Run ITL-1A

Two 300 gal/min Nozzles Operating Alternately (Pump Spray Ring Initially Operated to Form a Sump Around the Pump and Then Flow to Spray Ring Shut Off)

Run ITL-1A: Test effectiveness of two 300 gpm nozzles operating alternately with no flow to the pump spray ring to mobilize K-65 surrogate. (Note: the pump spray ring will be utilized to form an initial sump around the slurry pump.)

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that the DAS has been set up to record pump ring parameters used to form the sump: Pressure (PIT-PMP-11-254) and Flow (FE-PMP-11-254A).

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02), and Temperature (FET-SLR-11-200). ______ (yes/no)

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: ____________ (yes/no).

Attach graphs from data logged through DAS
1. Pressures as a function of time
2. Flows as a function of time
3. % solids as a function of time
4. Pump load as a function of time
5. Temperature as a function of time

Run ITL-1A: Comments on effectiveness of two 300 gpm nozzles operating alternately with no flow to the pump spray ring to mobilize K-65 surrogate.

Comments on the effectiveness of the pump spray ring to form an initial sump around the slurry pump (include a description and a sketch of the size of the sump formed by the spray ring):

Run ITL-1A: Comments on effectiveness of two 300 gpm nozzles operating alternately with no flow to the pump spray ring to mobilize K-65 surrogate, continued:

Include a sketch of the areas covered and not covered by the nozzles.

Water level in the standpipe after test.

Appendix 2

Data Logs For Run ITL-1B

Two 150 gal/min Nozzles Operating Simultaneously (Pump Spray Ring Initially Operated to Form a Sump Around the Pump and Then Flow to Spray Ring Shut Off)

Run ITL-1B: Test effectiveness of two 150 gpm nozzles operating simultaneously with no flow to the pump spray ring to mobilize K-65 surrogate. (Note: the pump spray ring will be utilized to form an initial sump around the slurry pump.)

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that the DAS has been set up to record pump ring parameters used to form the sump: Pressure (PIT-PMP-11-254) and Flow (FE-PMP-11-254A).

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200, FET-TST-02), % Solids (FET-TST-02), and Temperature (FET-SLS-11-200). ______ (yes/no)

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: ____________ (yes/no).

Attach graphs from data logged through DAS

(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Run ITL-1B: Comments on effectiveness of two 150 gpm nozzles operating simultaneously with no flow to the pump spray ring to mobilize K-65 surrogate:

Comments on the effectiveness of the pump spray ring to form an initial sump around the slurry pump (include a description and sketch of the size of the sump formed by the spray ring):

Run ITL-1B: Comments on effectiveness of two 150 gpm nozzles operating simultaneously with no flow to the pump spray ring to mobilize K-65 surrogate, continued:

Include a sketch of the areas covered and not covered by the nozzles.

Standpipe level after the run.

Appendix 3

Optional Runs
Data Logs For Run ITL-1C

Evaluation Using Nozzle Inserts
At Flows Other Than 150 or 300 gal/min

Run ITL-1C: Test effectiveness of nozzles with inserts operating at flows other than 150 or 300 gal/min to mobilize K-65 surrogate.

Nozzle Configuration: ____

Spray Ring Configuration: ____

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that the DAS has been set up to record pump ring parameters used to form the sump: Pressure (PIT-PMP-11-254) and Flow (FE-PMP-11-254A).

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200, FET-TST-02), % Solids (FET-TST-02), and Temperature (FET-SLR-11-200). ______ (yes/no)

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: ____________ (yes/no).

Attach graphs from data logged through DAS
(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Run ITL-1C: Comments on effectiveness of nozzles with inserts operating at flows other than 150 or 300 gal/min to mobilize K-65 surrogate (include sketch of the size of the sump formed by the spray ring, if applicable):

Run ITL-1C: Comments on effectiveness of nozzles with inserts operating at flows other than 150 or 300 gal/min to mobilize K-65 surrogate, continued:

Include a sketch of the areas covered and not covered by the nozzles.

Level in standpipe after test:

Appendix 4

Data Logs For Run ITL-2

ITL Series 2 Runs Based on Parameters From ITL Series 1 Runs Which Were Most Effective In Mobilizing the K-65 Surrogate

Run ITL-2: (1) Perform an integrated test using the parameters from the ITL Series 1 runs which provided the best results, (2) verify the operation of the mass flow meters and Isolok samplers, (3) determine the range of solids handled by slurry pump during integrated testing with K-65 surrogate, (4) determine the variability in system parameters [i.e., pressure, flow, etc.] during an integrated test with K-65 surrogate, and (5) close the water/solids material balance during the integrated run.

Nozzle Configuration:

____

Pump Spray Ring Configuration:

____

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that the DAS has been set up to record pump ring parameters used to form the sump: Pressure (PIT-PMP-11-254) and Flow (FE-PMP-11-254A).

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200, FET-TST-02), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02), and Temperature (FET-SLR-11-200). ______ (yes/no)

Verified that the Isolok samplers have been setup to take composite samples over the entire Run ITL-1 operational period: __________ (yes/no).

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: _____________ (yes/no).

Sample Schedule for Run ITL-2

1) Composite sample from ISS-TST-01 over the duration of the run.
   Analyses: density, percent solids

   Sample Number: ______________, sample time_____________.

2) Composite sample from ISS-TST-02 over the duration of the run.
   Analyses: density, percent solids

Sample Number: ______________, sample time______________.

3) Grab sample (250-500 mL) from slurry pump effluent 20 minutes and 40 minutes into run.

Analyses: density, percent solids, settling rate, particle size distribution

@20 min: Sample Number: ________________, Sample Time: ________________.

@40 min: Sample Number: ________________, Sample Time: ________________.

Run ITL-2:

Attach graphs from data logs

(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time for slurry pump discharge (data from mass flow meters and Isolok samplers)
(4) % solids as a function of time for sluicer supply (data from mass flow meters and Isolok samplers)
(5) Pump load as a function of time
(6) Temperature as a function of time

Run ITL-2: Comments on Run ITL-2:

1) Include comment on pump spray ring, if applicable.
2) Include a sketch of the areas covered and not covered by the nozzle.

Run ITL-2: Comments on Run ITL-2, continued:

Level in standpipe after test.

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Appendix 5

Data Logs For Run ITL-3

ITL Series 3 Runs To Determine Effects of Reduced Flow on Slurry Pump

Run ITL-3: Determine the need for a variable frequency drive for the slurry pump using most effective parameters identified from ITL Runs 1 and 2.

Nozzle Configuration:

____

Pump Spray Ring Configuration:

____

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02). ______ (yes/no)

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: _____________ (yes/no).

Run ITL-3: Variable frequency drive data log.

Date/Time	Pump Flow (gpm)	Comments

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Appendix 6

Data Logs For Run ITL-4

ITL Series 4 Runs on K-65 Surrogate With a Bentogrout Cap

Run ITL-4: Test most effective parameters identified in ITL Runs 1 and 2 to (1) determine the effectiveness of breakup and mobilization of the Bentogrout cap. (2) determine the effectiveness of mobilizing a K-65/Bentogrout combination, (3) verify mass flow meter accuracy with grab samples from the Isolok samplers, (4) close the material balance, and (5) determine the slurry pump load with a combination of Bentogrout and K-65.

Nozzle Configuration:

____

Pump Spray Ring Configuration:

____

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that the DAS has been set up to record pump ring parameters used to form the sump: Pressure (PIT-PMP-11-254) and Flow (FE-PMP-11-254A).

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load , and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02), and Temperature (FET-SLR-11-200).
______ (yes/no)

Verified that the Isolok samplers have been set up to take a composite sample over the entire operational period for this run ____________ (yes/no).

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: _____________ (yes/no).

Attach graphs from data logs
(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Sample Schedule for ITL-4:

1) Take a composite sample with ISS-TST-01 over the duration of the run.
Analyses: density, percent solids

Sample Number: ________________, Sample Time: ____________________.

2) Take a composite sample with ISS-TST-02 over the duration of the run.
Analyses: density, percent solids

Sample Number: ________________, Sample Time: ____________________.

Run ITL-4: Comments on effectiveness at mining using this configuration, including (1) effective radius of nozzles for breaking Bentogrout cap, (2) effectiveness at directing Bentogrout slurry to pump, (3) effectiveness with K-65/bentogrout combination, (4) problems noted during operation to include instrument stability, and (5) effectiveness of pump spray ring.

Include a sketch and description of the sump formed around the pump by the spray ring, if applicable.

Run ITL-4: Comments on effectiveness at mining using this configuration, including (1) effective radius of nozzles for breaking Bentogrout cap, (2) effectiveness at directing Bentogrout slurry to pump, (3) effectiveness with K-65/bentogrout combination, (4) problems noted during operation to include instrument stability, and (5) effectiveness of pump spray ring. (Continued)

Appendix 7

Data Logs For Run ITL-5

ITL Series 5 Runs to Determine System Parameters Resulting from a Partial or Complete Block in the Slurry Pump Discharge Line

Run ITL-5: Determine ITL parameters with full or partial blockage in slurry pump discharge line.

Nozzle Configuration: ____

Pump Spray Ring Configuration: ____________________________________

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200), Pump load, and temperature (FET- SLR-11-200). (yes/no)

Verified prior to run that DAS set up to record pump spray ring parameters of Flow [FE-PMP-11-254A], and Pressure [PIT-PMP-11-254]. ______ (yes/no)

Level of water in surrogate material tank standpipes before run: ____________.

Level of water in surrogate material tank standpipes after run: ____________.

Verify that depth profiles of solids in the surrogate material tank were recorded before and after this run: _____________ (yes/no).

Attach graphs from data logs

(1) Pressure as a function of time
(2) Flow as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Run ITL-5: Run to determine ITL parameters with fully or partially blocked slurry pump discharge line

Date/Time	Valve Position (% Closed)	% Solids FET(SLR -11-200) (%)	Mass Flow FET(SLR-11-200)	Pressure PIT(SLR-11-200) (psi)	Pump Load (Amps)	Comments

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Appendix 8

Data Logs For Run ITL-6

ITL Series 6 Runs to Evaluate the Ability of the Pump to Handle Debris from the Silos Which Can't be Removed with Long Handle Tools

Run ITL-6: Test the effectiveness of the pump and agitator to handle debris.

Nozzle Configuration: ____

Pump Spray Ring Configuration: _____________________________________

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200, FET-TST-02), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02). ______ (yes/no)

Verified prior to run that DAS set up to record pump spray ring parameters of Flow [FE-PMP-11-254A], and Pressure [PIT-PMP-11-254]. ______ (yes/no)

Attach graphs from data logs

(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Run ITL-6: Pump/Agitator handling of debris.

Date/Time	Description Debris/Slurry	Comments
	Photo No:	Final Description: Photo No:
	Photo No:	Final Description: Photo No:
	Photo No:	Final Description: Photo No:
	Photo No:	Final Description: Photo No:

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Appendix 9

Data Logs For Run ITL-7

Startup Evaluation Following an Off-Normal Shutdown

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Run ITL-7: Test startup following an off-normal shutdown.

Nozzle Configuration: ____

Pump Spray Ring Configuration: ____

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-SLR-11-200), % Solids (FET- SLR-11-200), Flow (FET- SLR-11-200, FET-TST-02), Pump load, and sluice parameters of Pressure (PIT-PMP-12-200), Pressure (PIT-SLC-1-201), Pressure (PIT-SLC-11-202), Flow (FT-PMP-12-200), % Solids (FET-TST-02). ______ (yes/no)

Attach graphs from data logs
(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Run ITL-7: Comments on re-start of system following an off-normal shutdown.

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Appendix 10

Data Logs For Run CTL-1

Run CTL-1: Abrasion and wear data, determine critical velocity as a function of percent solids, verify accuracy of mass flow meters, determine load on pump as a function of percent solids.

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-PMP-12-201), % Solids (FET-TST-01), Flow (FET- TST-01, FT-PMP-12-201), Pump load. ______ (yes/no)

Verified that preoperational photos and ultrasonic measurements have been taken and data recorded. ____________ (yes/no)

Verify the pump curves have been generated with water for comparison with the manufacturers pump curves and curves developed after completion of tests with the CTL system. _______________ (yes/no)

Attach graphs from data logged through DAS

(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

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Sample Schedule for CTL-1:

1)* Take 10 minute composite samples every 4 hours while operating at 5% solids (1 day).
Analyses: density, percent solids, solids distribution

2)* Take 10 minute composite samples every 4 hours while operating at 10% solids (1 day).
Analyses: density, percent solids, solids distribution

3)* Take 10 minute composite samples every 12 hours while operating at 15% solids (23 days).
Analyses: density, percent solids, solids distribution (every other sample)

4)* Take 10 minute composite samples twice while operating with 10% K-65 and 1% Bentogrout solids.
Analyses: density, percent solids, solids distribution

5)* Take 10 minute composite samples twice while operating with 10% K-65 and 3% Bentogrout solids.
Analyses: density, percent solids, solids distribution

Note: Make sure sample numbers, time period sample was taken over, and process parameters are recorded on data sheet. Process parameters should be recorded every 2 minutes over the 10 minute sample period.

Run CTL-1: Data log for photographs taken during Run CTL-1 for abrasion/erosion determination.

Date/Time	Cumulative Run Time (hrs)	Item Description	Photo Number	Comments
	0			Prestart baseline photos.

Run CTL-1: Data log for photographs taken during Run CTL-1 for abrasion/erosion determination.

Date/Time	Cumulative Run Time (hrs)	Item Description	Photo Number	Comments
				After CTL-1 run completed

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Run CTL-1: Data log for ultrasonic measurements taken during Run CTL-1 to evaluate abrasion/erosion.

Date/Time	Cumulative Run Time (hrs)	Item Description	Ultrasonic Measurement (Units)	Comments
	0			Prestart baseline measurements.

Run CTL-1: Data log for ultrasonic measurements taken during Run CTL-1 to evaluate abrasion/erosion.

Date/Time	Cumulative Run Time (hrs)	Item Description	Ultrasonic Measurement (Units)	Comments
				After completion of CTL-1 run

Run CTL-1: Determination of critical velocity at various percent solids. To be recorded once at each percent solid prior to going to the next higher solids concentration.

Date/Time	**% Solids (FET-TST-01) (%)**	**Pressure PIT/ PMP-12-201 (psig)**	**Mass Flow (FET-TST-01) (units)**	**Critical Velocity (ft/sec)**	**Pump Load (Amps)**	**Comments**
						Critical velocity K-65 at 5% solids:
						Critical velocity K-65 at 10% solids
						Critical velocity K-65 at 15% solids
						Critical velocity K-65 at 10% solids, 1% Bentogrout
						Critical velocity K-65 at 10% solids, 3% Bentogrout

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Run CTL-1: Summary of comments on abrasion tests and recommendation by Hazelton Pump Representative.

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Appendix 11

Sample and Data Log for Run CTL-2 To Evaluate Operation with Various Bentogrout Concentrations Ranging from 1-5 Weight Percent

Run CTL-2: Document operation of slurry pump with Bentogrout, verify operation of mass flow meters and Isolok samplers on bentogrout, determine variability in system parameters, determine load on pump with bentogrout.

Verified prior to run that the DAS is operational and there is enough memory available to record test results. ______ (yes/no)

Verified prior to run that DAS set up to record slurry pump parameters of Pressure (PIT-PMP-12-201), % Solids (FET-TST-01), Flow (FET- TST-01, FT-PMP-12-201), Pump load. ______ (yes/no)

Verify that pump curves have been generated with water for comparison with the pump curves developed prior to testing. ____________ (yes/no)

Attach graphs from data logged through DAS
(1) Pressures as a function of time
(2) Flows as a function of time
(3) % solids as a function of time
(4) Pump load as a function of time
(5) Temperature as a function of time

Sample Schedule for CTL-1:

1)* Take 10 minute composite samples every once at every composition
Analyses: density, percent solids, solids distribution

Note: Make sure sample numbers, time period sample was taken over, and process parameters are recorded on data sheet. Process parameters should be recorded every 2 minutes over the 10 minute sample period.

Run CTL-2: Sample and data log for CTL Run 2.

Date/Time	Slurry Composition Bentogrout (wt. %)	Sample Number	Temp (FET-TST-01)	Flow (FT-PMP-12-201) (gal/min)	% Solids FET (TST-01) (%)	Flow (FET-TST-01) Flow (units)	PIT (PMP-12-211) Pressure (psi)	Pump Load (Amps)
	1%							
	2%							
	3%							
	4%							
	5%							

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